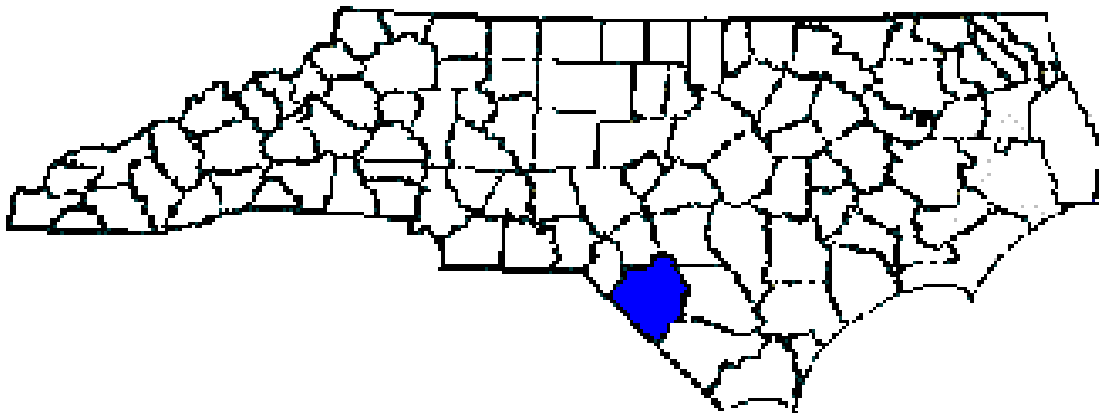


ANNUAL REPORT FOR 2009



**Unnamed Tributary to Little Jacob
Swamp Mitigation Site
Robeson County
TIP No. R-0513WM**



Prepared By:
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North Carolina Department of Transportation
December 2009

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SUMMARY

The following report summarizes the stream monitoring activities that have occurred during 2009 at the Unnamed Tributaries to Little Jacob Swamp (UT to Little Jacob Swamp) Mitigation Site in Robeson County. The site was constructed during 2007 by the North Carolina Department of Transportation (NCDOT). This report provides the monitoring results for the second formal year of monitoring (Year 2009). The Year 2009 monitoring period is the second of five scheduled years of monitoring on UT to Little Jacob Swamp (See Success Criteria Section 2.1).

Based on the overall conclusions of monitoring along UT to Little Jacob Swamp, the site has met the required monitoring protocols for the second formal year of monitoring. Based on comparing the second year of monitoring data to the as-built and 2008 monitoring data, the channel remains stable throughout the stream at this time. The stream bank is heavily vegetated for the second year of monitoring. The vegetation in the stream buffer area was replanted in 2009 and is now meeting the success criteria for the second year of monitoring.

NCDOT will continue stream monitoring at the UT to Little Jacob Swamp Mitigation Site in 2010.

1.0 INTRODUCTION

1.1 Project Description

The following report summarizes the stream monitoring activities that have occurred during 2009 at the UT to Little Jacob Swamp Mitigation Site. The site is located adjacent to the US 74 eastbound lanes at the SR 2418 Crawford Road intersection near Lumberton (Figure 1). The UT to Little Jacob Swamp Mitigation Site was constructed to provide mitigation for stream impacts associated with Transportation Improvement Program (TIP) number R-0513 in Robeson County.

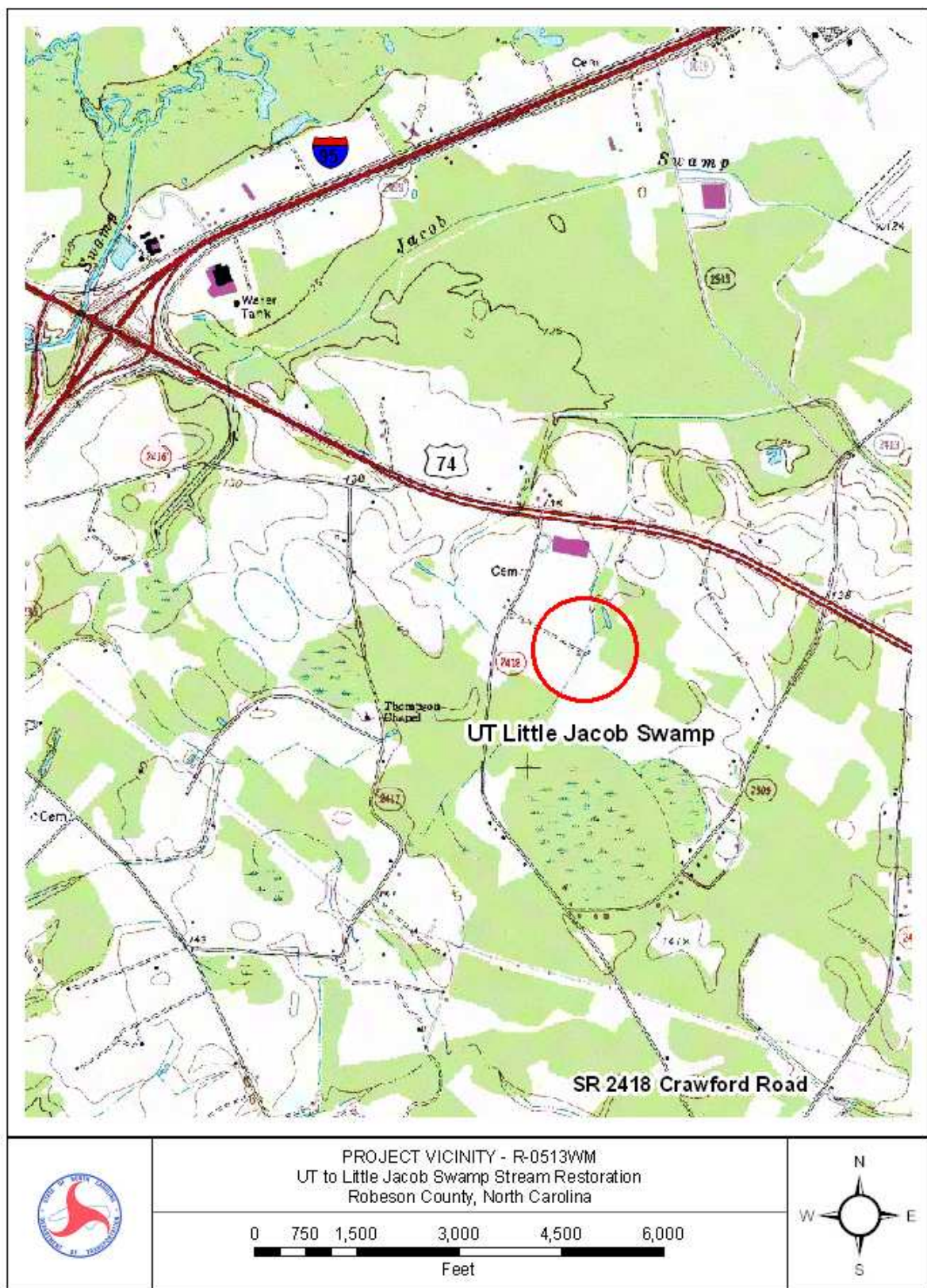
The mitigation project covers approximately 3,140 linear feet of Priority II stream restoration. Construction was completed in December 2007 by the North Carolina Department of Transportation (NCDOT). Stream restoration involved the installation of rock cross vanes, log cross vanes, log sills and rootwads, construction of a new stream channel and construction of the floodplain to allow for overbank flooding. It also included the installation of coir fiber matting and live stakes along the streambank and bareroot seedlings in the buffer area.

1.2 Purpose

In order for a mitigation site to be considered successful, the site must meet the success criteria. This report details the monitoring in 2009 at the UT to Little Jacob Swamp Mitigation Site. Hydrologic monitoring was not required for the site.

1.3 Project History

December 2007	Construction Completed
March 2008	Planted Live Stakes and Bareroot Seedlings
August 2008	Vegetation Monitoring (1 yr.)
October 2008	Stream Channel Monitoring (1 yr.)
February 2009	Replanted Bareroot Seedlings
July 2009	Vegetation Monitoring (2 yr.)
November 2009	Stream Channel Monitoring (2 yr.)



2.0 STREAM ASSESSMENT

2.1 Success Criteria

In accordance with the approved mitigation plan, NCDOT will evaluate the success of the stream restoration project based on guidance provided by the Stream Mitigation Guidelines disseminated by the United States Army Corps of Engineers-Wilmington District. The survey of channel dimension will consist of permanent cross sections placed at approximately two cross sections (one riffle and one pool) per unique stream segment. The cross sections will represent approximately 50% riffles and 50% pools. Annual photographs showing both banks and upstream and downstream views will be taken from permanent, mapped photo points. The survey of the longitudinal profile will represent distinct areas of restoration and will cover a cumulative total of 3,000 linear feet of channel. Newly-constructed meanders will be surveyed to provide pattern measurements. The entire restored length of stream will be investigated for channel stability and in-stream structure functionality. Any evidence of channel instability will be identified, mapped and photographed.

Vegetation Success

The success of vegetation plantings will be measured through stem counts. Permanent quadrants will be used to sample the riparian buffer and restoration wetlands. Survival of the live stakes will be determined by visual observation throughout the five year monitoring period.

Bare root vegetation will be evaluated using five staked survival plots. Plots will be 25 ft. by 25 ft. and all flagged stems will be counted in those plots. Success will be defined as 320 stems per acre after three years and 260 stems per acre after five years. All vegetation monitoring will be conducted during the growing season.

2.2 Stream Description

2.2.1 Post-Construction Conditions

The mitigation project covers approximately 3,140 linear feet of Priority II stream restoration. Construction was completed in December 2007 by NCDOT. Stream restoration involved the installation of rock cross vanes, log cross vanes, log sills and rootwads, construction of a new stream channel and construction of the floodplain to allow for overbank flooding. It also included the installation of coir fiber matting and live stakes along the streambank and bareroot seedlings in the buffer area.

2.2.2 Monitoring Conditions

The objective of the UT to Little Jacob Swamp Mitigation Site restoration was to build a C5 stream type as identified in the Rosgen's Applied River Morphology. A total of eleven cross sections (six in a riffle, five in a pool) were surveyed. For this report, all cross sections were included in Table 1 but only cross sections containing riffles were used in the comparison of channel morphology.

Table 1. Abbreviated Morphological Summary (UT Little Jacob Swamp Cross Sections #1, #4, #6, #8, #10, & #11)									
Variable	Proposed	Cross Section #1 (Riffle)	Cross Section #4 (Riffle)	Cross Section #6 (Riffle)	Cross Section #8 (Riffle)	Cross Section #10 (Riffle)	Cross Section #11 (Riffle)	Min. - Max Values (Riffle Sections Only)	
		2009	2009	2009	2009	2009	2009	2009	
Drainage Area (sq. mi)	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	
Bankfull Width (ft)	14.1	10.04	16.27	9.75	9.8	11.1	9.0	9.0 - 16.27	
Bankfull Mean Depth (ft)	0.80	0.78	0.55	0.88	0.80	0.62	0.42	0.42 - 0.88	
Width/Depth Ratio	17.6	12.87	29.58	11.08	12.25	17.9	21.43	11.08 - 29.58	
Bankfull Cross Sectional Area (ft ²)	11.9	7.80	8.94	8.56	7.82	6.89	3.75	3.75 - 8.94	
Maximum Bankfull Depth (ft)	1.1	1.20	1.04	1.42	1.24	1.02	0.76	0.76 - 1.42	
Floodprone Area (ft)	70	55	80	68	63	64	68	55 - 80	
Entrenchment Ratio	5.0	5.48	4.92	6.97	6.43	5.77	7.56	4.92 - 7.56	

*Drainage Area, Floodprone Width, and Slope are averaged values only.

*Riffle values are used for classification purposes.

2.3 Results of the Stream Assessment

2.3.1 Site Data

The assessment included the survey of eleven cross sections and the longitudinal profile of UT to Little Jacob Swamp established by the NCDOT after construction. The length of the profile along UT to Little Jacob Swamp was approximately 3,047 linear feet. Eleven cross sections were established during the 2008 monitoring year. Cross section locations were subsequently based on the stationing of the longitudinal profile and are presented below. The locations of the cross sections and longitudinal profiles are shown in Appendix A.

- ◆ Cross Section #1. UT to Little Jacob Swamp, Station 200+00 linear feet, midpoint of riffle
- ◆ Cross Section #2. UT to Little Jacob Swamp, Station 434+00 linear feet, midpoint of pool
- ◆ Cross Section #3. UT to Little Jacob Swamp, Station 622+00 linear feet, midpoint of pool
- ◆ Cross Section #4. UT to Little Jacob Swamp, Station 897+00 linear feet, midpoint of riffle
- ◆ Cross Section #5. UT to Little Jacob Swamp, Station 1201+00 linear feet, midpoint of pool
- ◆ Cross Section #6. UT to Little Jacob Swamp, Station 1514+00 linear feet, midpoint of riffle
- ◆ Cross Section #7. UT to Little Jacob Swamp, Station 1883+00 linear feet, midpoint of pool
- ◆ Cross Section #8. UT to Little Jacob Swamp, Station 2250+00 linear feet, head of riffle
- ◆ Cross Section #9. UT to Little Jacob Swamp, Station 2471+00 linear feet, midpoint of pool
- ◆ Cross Section #10. UT to Little Jacob Swamp, Station 2734+00 linear feet, midpoint of riffle
- ◆ Cross Section #11. UT to Little Jacob Swamp, Station 2975+00 linear feet, head of riffle

Based on comparing the second year of monitoring data to the as-built and 2008 monitoring data, the channel and all eleven cross sections appear stable with little or no active bank erosion. Graphs of the cross sections are presented in Appendix A. Future survey data will vary depending on actual location of rod placement and alignment; however this information should remain similar in appearance.

2.4 Results of Stream and Buffer Vegetation

2.4.1 Description of Species

The following live stake species were planted on the streambank:

Cephalanthus occidentalis, Buttonbush

Cornus amomum, Silky Dogwood

The following tree species were planted in the buffer area:

Quercus falcate var. *pagodaefolia*, Cherrybark Oak

Quercus laurifolia, Laurel Oak

Quercus michauxii, Swamp Chestnut Oak

Quercus nigra, Water Oak

Myrica cerifera, Wax Myrtle

Nyssa sylvatica var. *biflora*, Swamp Blackgum

Nyssa aquatica, Water Tupelo

Taxodium distichum, Baldcypress

Fraxinus pennsylvanica, Green Ash

2.4.2 Results of Vegetation Monitoring

Table 2. Vegetation Monitoring Results: Five 25 ft. x 25 ft. vegetation plots were set to determine the trees per acre in the buffer area.

Plot #	Cherrybark Oak	Laurel Oak	Swamp Chestnut Oak	Water Oak	Wax Myrtle	Swamp Blackgum	Water Tupelo	Baldcypress	Green Ash	Total (2 year)	Total (at planting)	Density (Trees/Acre)
1						5	6	5		16	16	680
2		1					4		9	14	16	595
3	2	5	7				1	4	2	21	36	397
4	4	1	1		1	1	2	4		14	14	680
5	3	4	2	2			1	2		14	14	680
Average Density (Trees/Acre)												606

Site Notes: The buttonbush and silky dogwood live stakes were surviving along the stream bank. Other vegetation noted included *Juncus effusus*, black willow, woolgrass, stinkweed, trumpet creeper, red maple, cattail, briars, baccharis, ragweed, and various grasses.

2.4.3 Conclusions

There were five vegetation monitoring plots established throughout the buffer area. The 2009 vegetation monitoring of the site revealed an average tree density of 606 trees per acre. This average is above the minimum success criteria of 320 trees per acre after year two monitoring. The buffer area was replanted in February 2009.

3.0 OVERALL CONCLUSIONS/RECOMMENDATIONS

The UT to Little Jacob Swamp Mitigation Site has met the required monitoring protocols for the second formal year of monitoring. Based on comparing the second year of monitoring data to the as-built and 2008 monitoring data, the channel remains stable throughout the stream at this time. The stream bank is heavily vegetated for the second year of monitoring. The vegetation in the stream buffer area was replanted in 2009 and is now meeting the success criteria for the second year of monitoring.

NCDOT will continue stream monitoring at the UT to Little Jacob Swamp Mitigation Site for 2010.

4.0 REFERENCES

Wetland and Stream Mitigation Plan for UT to Little Jacob Swamp; Robeson County, NC, February, 2006.

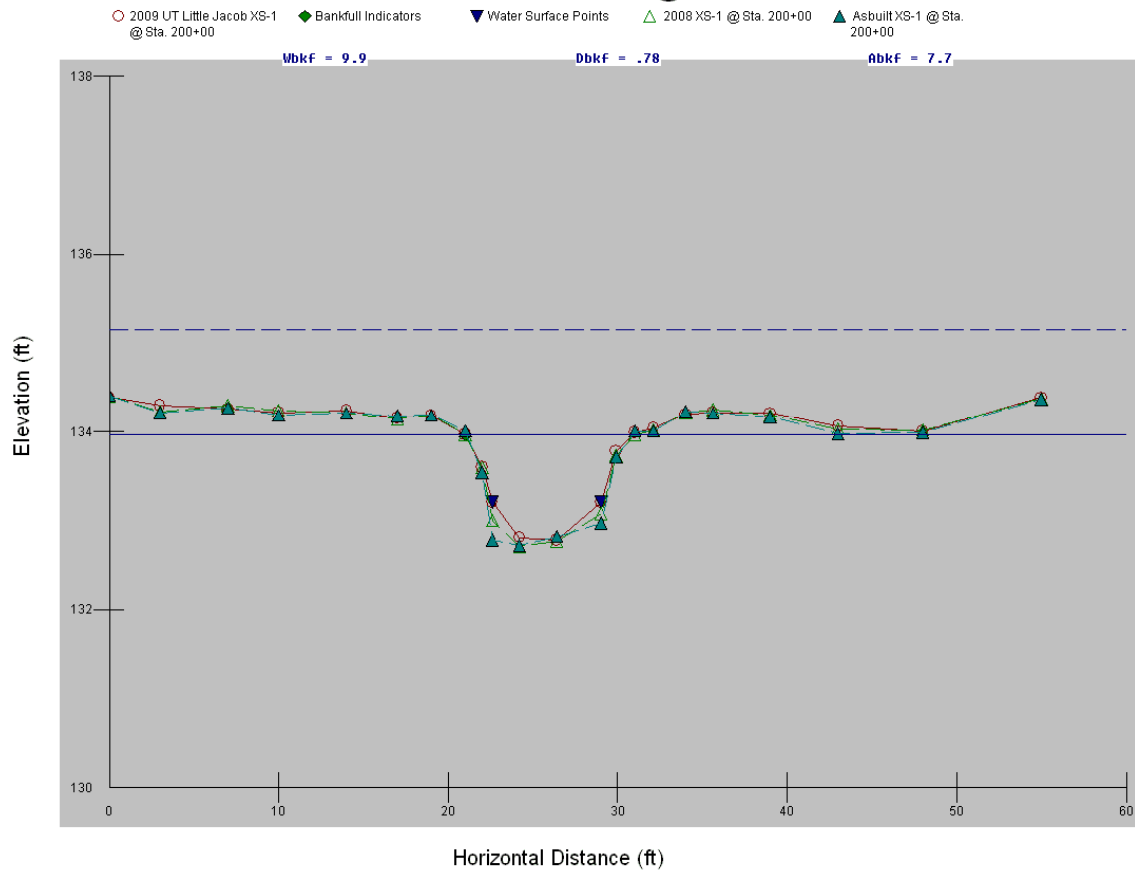
Rosgen, D.L, 1996. Applied River Morphology. Wildland Hydrology, Pagosa Springs, Colorado.

US Army Corps of Engineers (USACE), 2003. Stream Mitigation Guidelines. Prepared with cooperation from the US Environmental Protection Agency, NC Wildlife Resources Commission, and the NC Division of Water Quality.

APPENDIX A

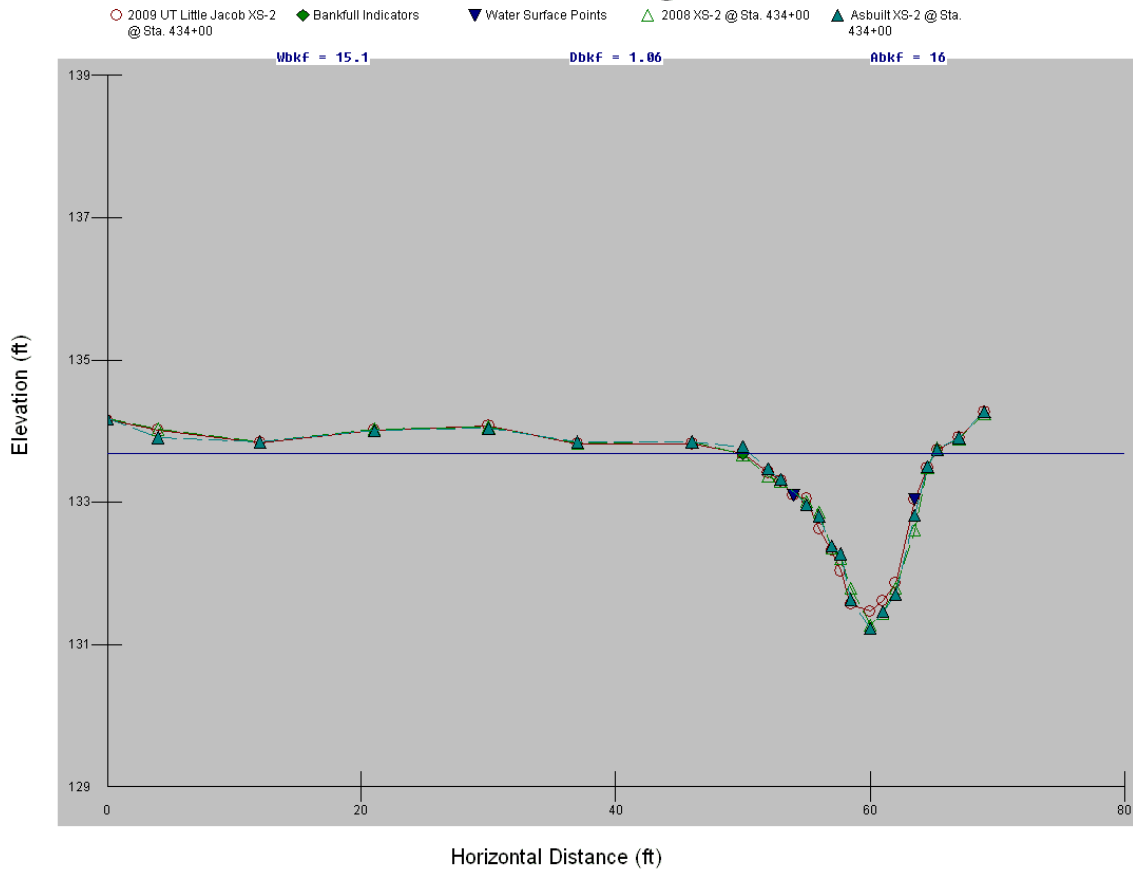
CROSS SECTION COMPARISONS
&
LONGTITUDINAL PROFILE

2009 UT Little Jacob XS-1 @ Sta. 200+00



Cross-Section #1 (Riffle) Abbreviated Morphological Summary					
	2008	2009	2010	2011	2012
Bankfull Width (ft)	10.0	10.04			
Bankfull Mean Depth (ft)	0.84	0.78			
Width/Depth Ratio	11.9	12.87			
Bankfull Cross Sectional Area (ft ²)	8.44	7.80			
Maximum Bankfull Depth (ft)	1.26	1.20			
Width of the Floodprone Area (ft)	55	55			
Entrenchment Ratio	5.5	5.48			

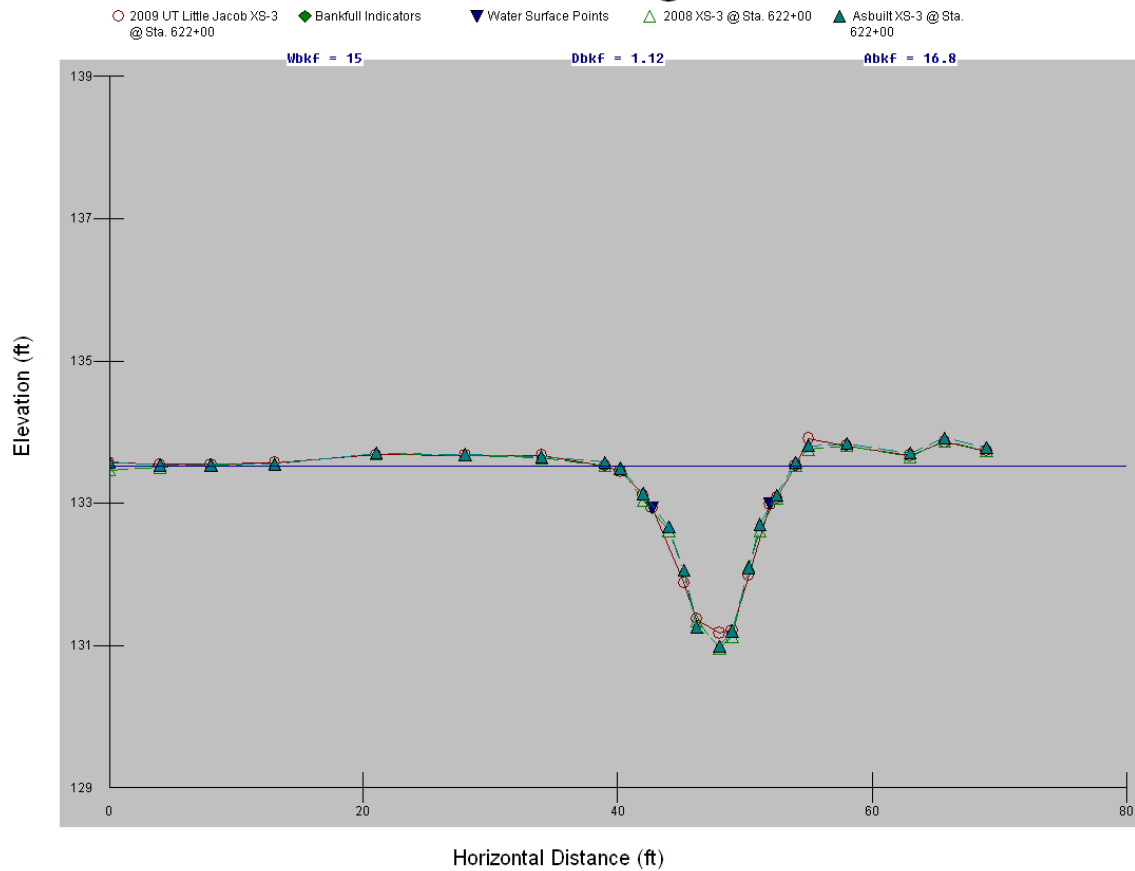
2009 UT Little Jacob XS-2 @ Sta. 434+00



Cross-Section #2 (Pool) Abbreviated Morphological Summary*					
	2008	2009	2010	2011	2012
Bankfull Cross Sectional Area (ft ²)	16.17	16.01			
Maximum Bankfull Depth (ft)	2.39	2.22			
Bankfull Mean Depth (ft)	1.08	1.06			
Bankfull Width (ft)	15.03	15.14			

* According to the Rosgen Classification of Natural Rivers floodprone width, entrenchment ratio, and width depth ratio are not measured in pool, glide, or run features.

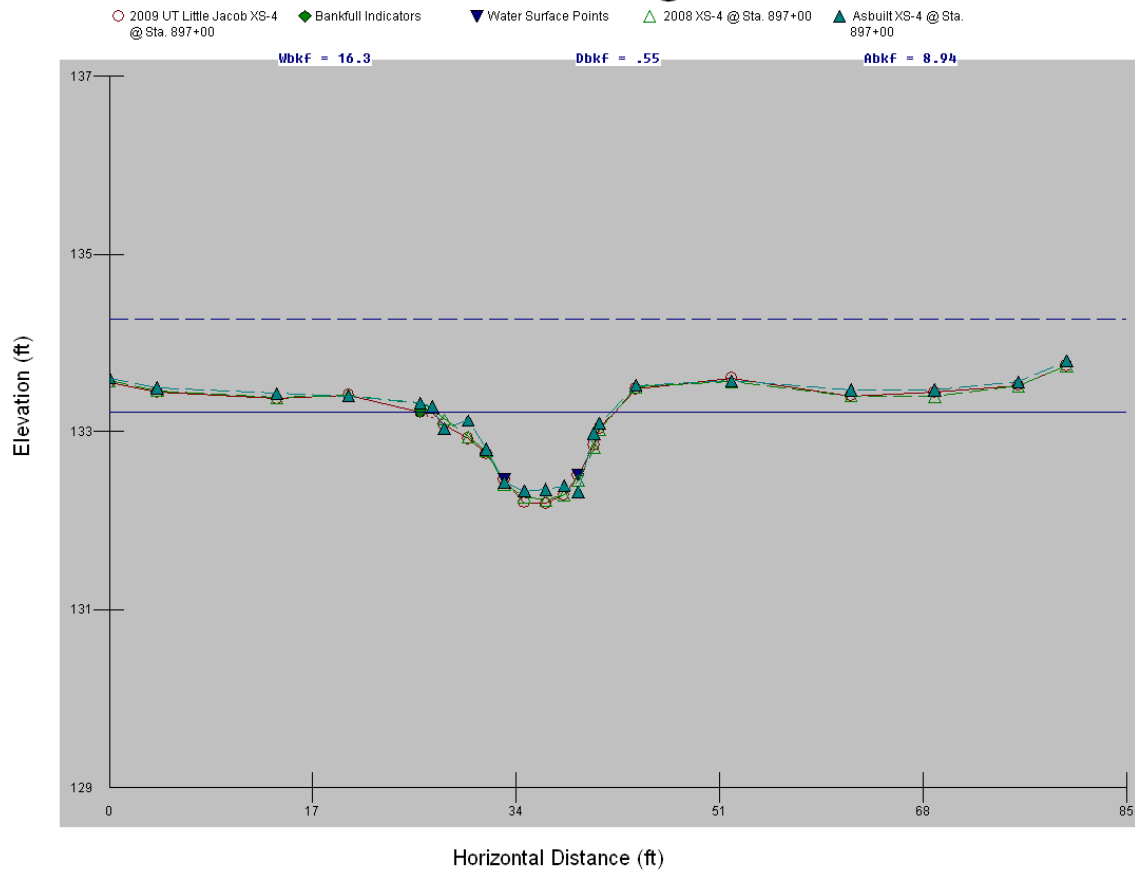
2009 UT Little Jacob XS-3 @ Sta. 622+00



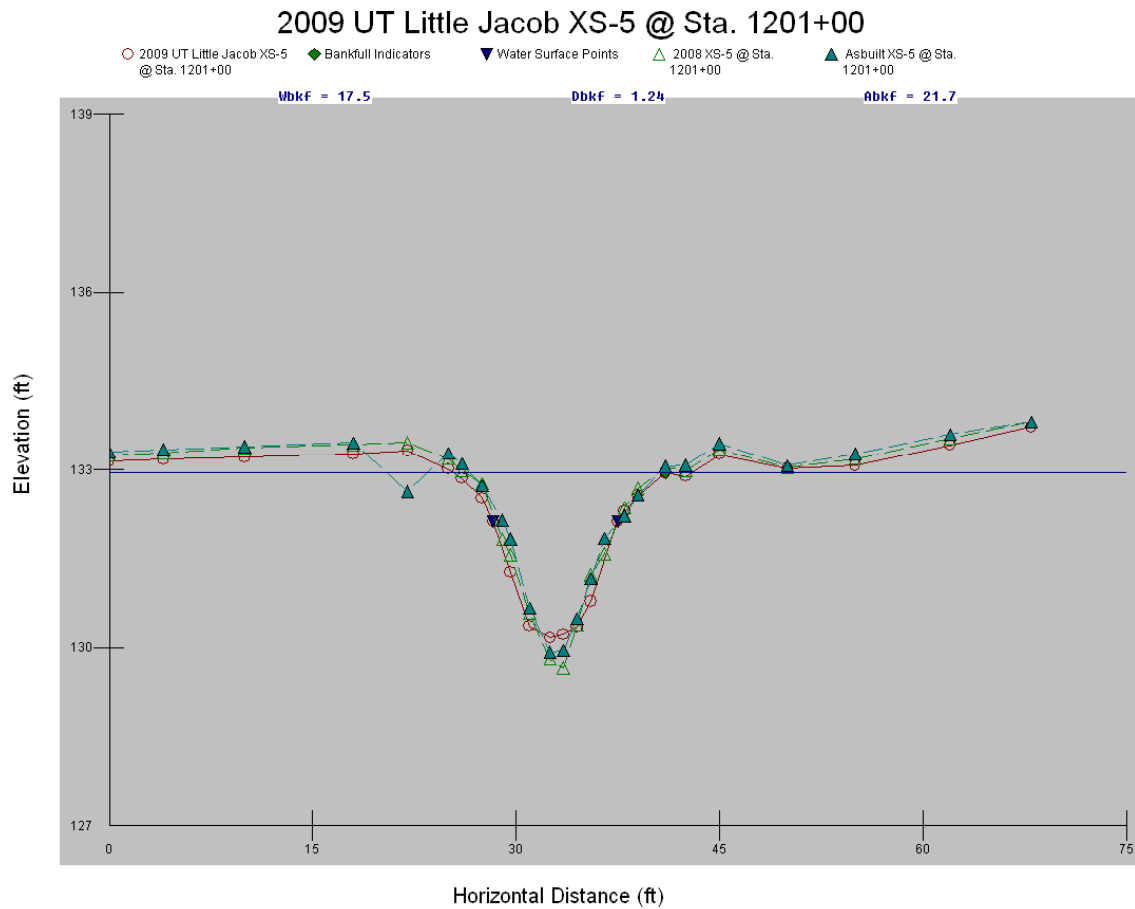
Cross-Section #3 (Pool) Abbreviated Morphological Summary*					
	2008	2009	2010	2011	2012
Bankfull Cross Sectional Area (ft ²)	16.78	16.76			
Maximum Bankfull Depth (ft)	2.56	2.35			
Bankfull Mean Depth (ft)	0.8	1.12			
Bankfull Width (ft)	21.0	15			

* According to the Rosgen Classification of Natural Rivers floodprone width, entrenchment ratio, and width depth ratio are not measured in pool, glide, or run features.

2009 UT Little Jacob XS-4 @ Sta. 897+00



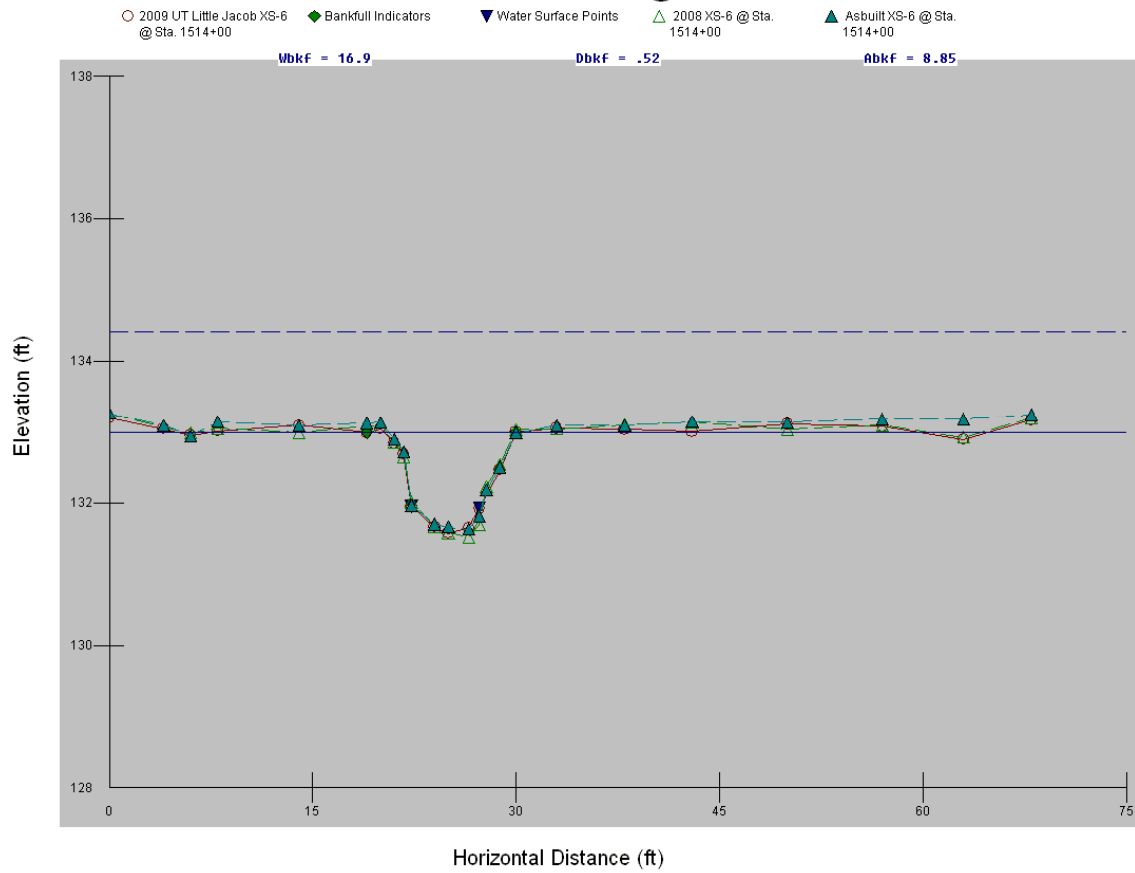
Cross-Section #4 (Riffle) Abbreviated Morphological Summary					
	2008	2009	2010	2011	2012
Bankfull Width (ft)	16.84	16.27			
Bankfull Mean Depth (ft)	0.60	0.55			
Width/Depth Ratio	28.07	29.58			
Bankfull Cross Sectional Area (ft ²)	10.16	8.94			
Maximum Bankfull Depth (ft)	1.09	1.04			
Width of the Floodprone Area (ft)	80	80			
Entrenchment Ratio	4.75	4.92			



Cross-Section #5 (Pool) Abbreviated Morphological Summary*					
	2008	2009	2010	2011	2012
Bankfull Cross Sectional Area (ft ²)	22.13	20.88			
Maximum Bankfull Depth (ft)	3.39	2.73			
Bankfull Mean Depth (ft)	1.24	1.42			
Bankfull Width (ft)	8.91	14.74			

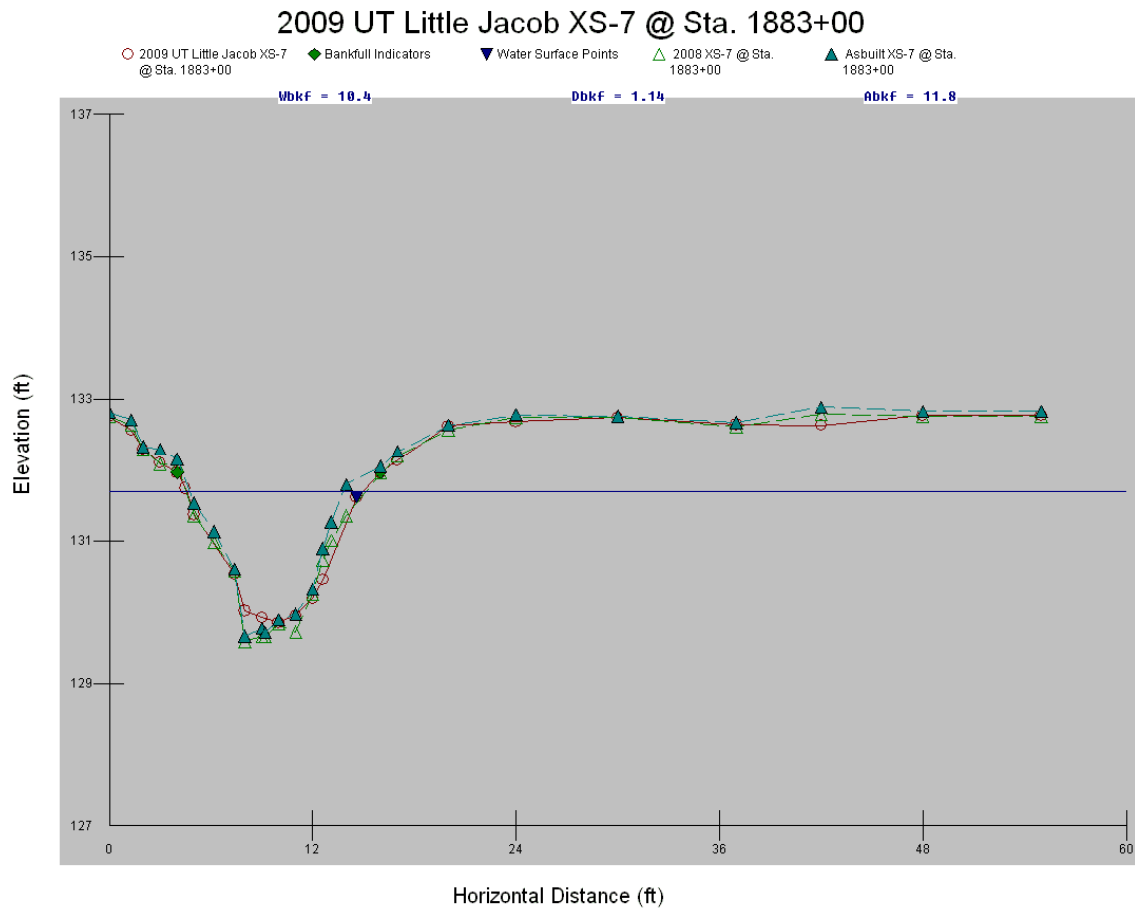
* According to the Rosgen Classification of Natural Rivers floodprone width, entrenchment ratio, and width depth ratio are not measured in pool, glide, or run features.

2009 UT Little Jacob XS-6 @ Sta. 1514+00



Cross-Section #6 (Riffle) Abbreviated Morphological Summary

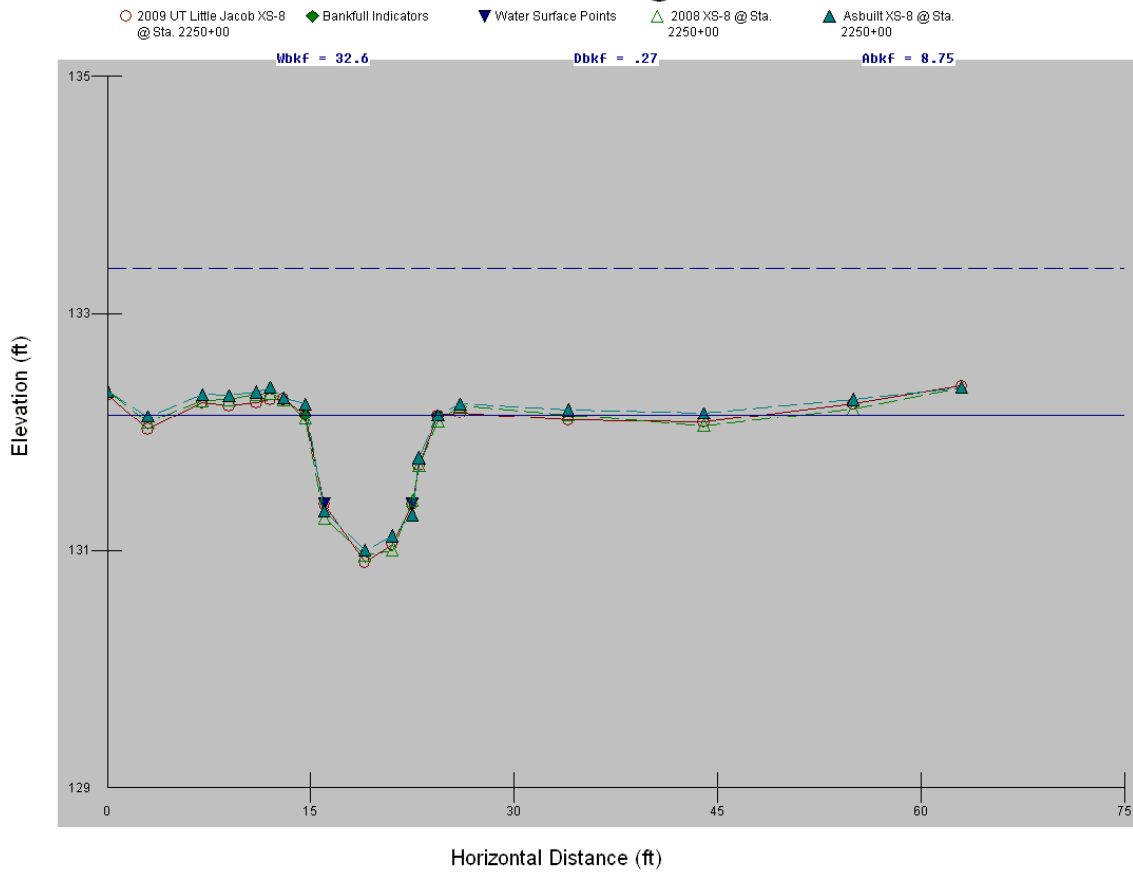
	2008	2009	2010	2011	2012
Bankfull Width (ft)	9.8	9.75			
Bankfull Mean Depth (ft)	0.91	0.88			
Width/Depth Ratio	10.77	11.08			
Bankfull Cross Sectional Area (ft ²)	8.94	8.56			
Maximum Bankfull Depth (ft)	1.51	1.42			
Width of the Floodprone Area (ft)	68	68			
Entrenchment Ratio	6.94	6.97			



Cross-Section #7 (Pool) Abbreviated Morphological Summary*					
	2008	2009	2010	2011	2012
Bankfull Cross Sectional Area (ft ²)	15.14	14.80			
Maximum Bankfull Depth (ft)	2.37	2.11			
Bankfull Mean Depth (ft)	0.80	1.23			
Bankfull Width (ft)	11.85	12.0			

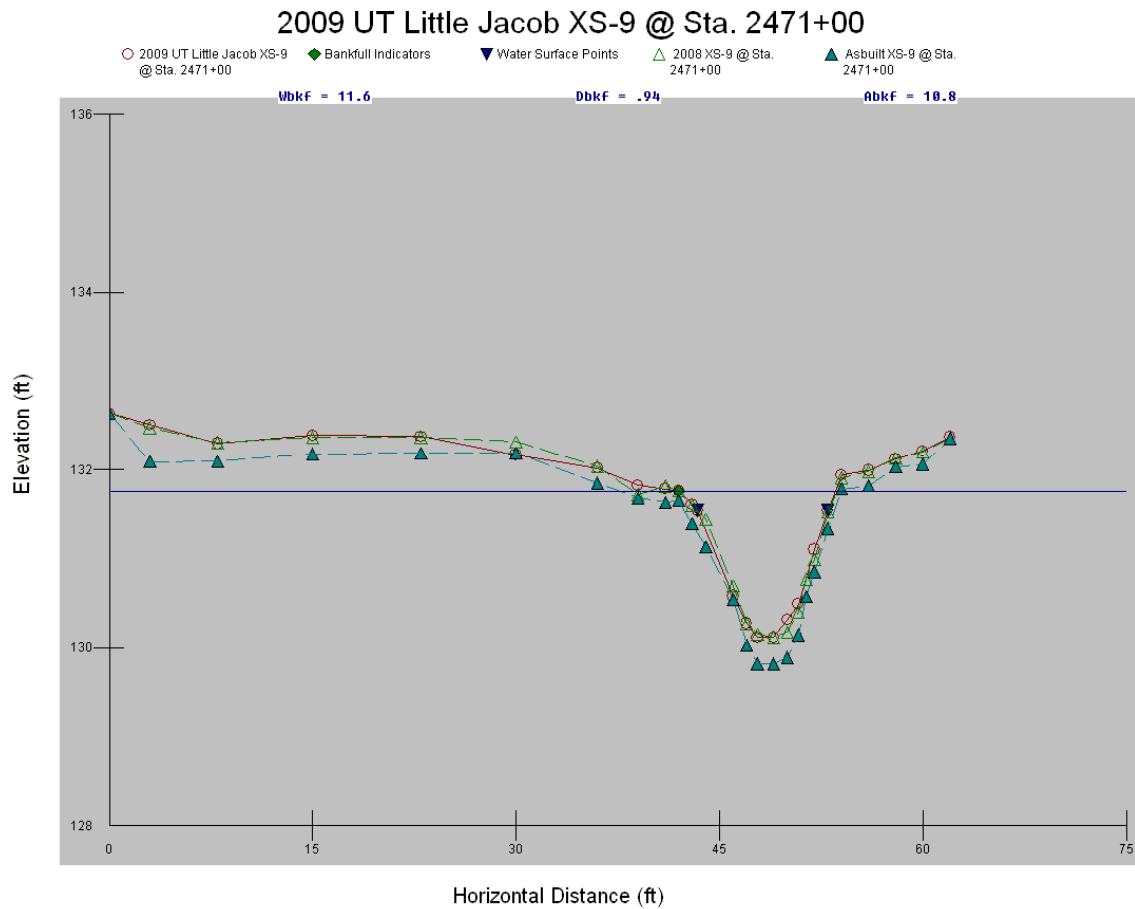
* According to the Rosgen Classification of Natural Rivers floodprone width, entrenchment ratio, and width depth ratio are not measured in pool, glide, or run features.

2009 UT Little Jacob XS-8 @ Sta. 2250+00



Cross-Section #8 (Riffle) Abbreviated Morphological Summary

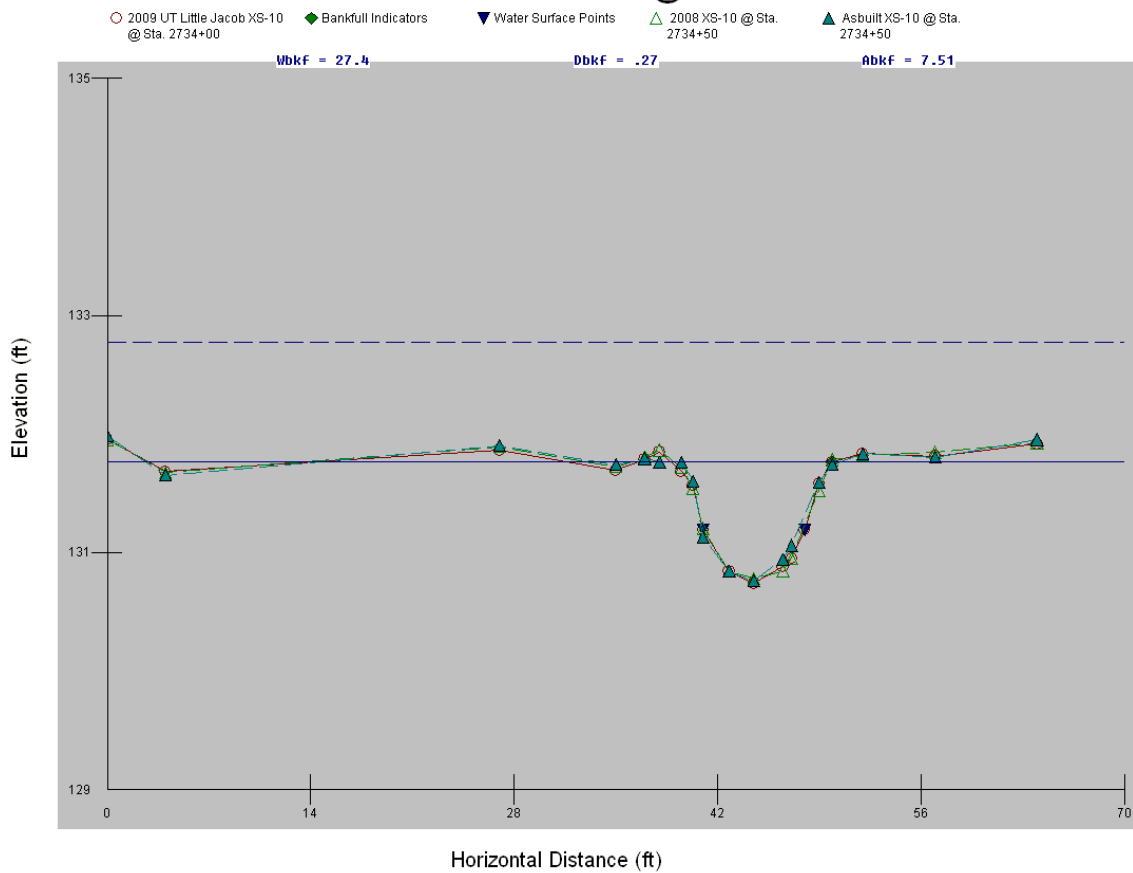
	2008	2009	2010	2011	2012
Bankfull Width (ft)	9.77	9.8			
Bankfull Mean Depth (ft)	0.78	0.80			
Width/Depth Ratio	12.53	12.25			
Bankfull Cross Sectional Area (ft ²)	7.64	7.82			
Maximum Bankfull Depth (ft)	1.14	1.24			
Width of the Floodprone Area (ft)	63	63			
Entrenchment Ratio	6.45	6.43			



Cross-Section #9 (Pool) Abbreviated Morphological Summary*					
	2008	2009	2010	2011	2012
Bankfull Cross Sectional Area (ft ²)	10.8	10.84			
Maximum Bankfull Depth (ft)	1.64	1.65			
Bankfull Mean Depth (ft)	0.93	0.94			
Bankfull Width (ft)	11.56	11.55			

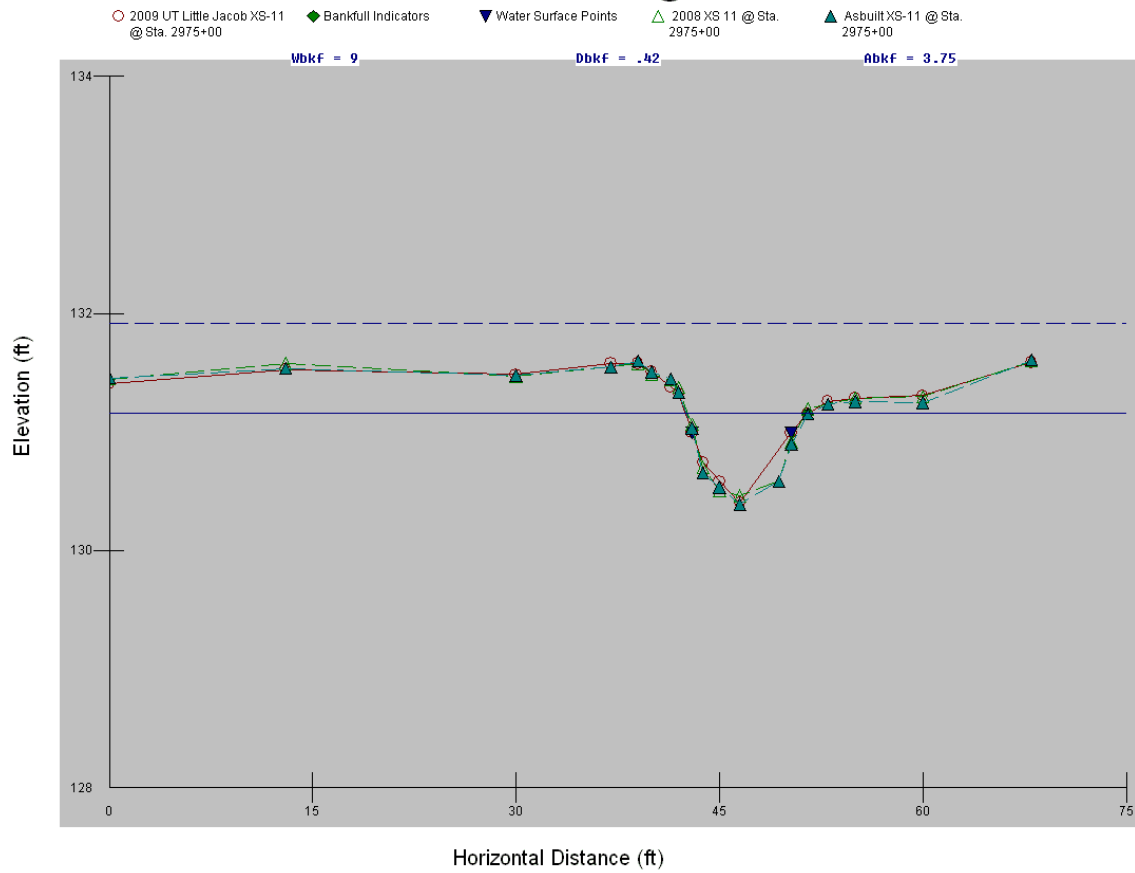
* According to the Rosgen Classification of Natural Rivers floodprone width, entrenchment ratio, and width depth ratio are not measured in pool, glide, or run features.

2009 UT Little Jacob XS-10 @ Sta. 2734+50



Cross-Section #10 (Riffle) Abbreviated Morphological Summary					
	2008	2009	2010	2011	2012
Bankfull Width (ft)	11.1	11.1			
Bankfull Mean Depth (ft)	0.64	0.62			
Width/Depth Ratio	17.34	17.9			
Bankfull Cross Sectional Area (ft ²)	7.08	6.89			
Maximum Bankfull Depth (ft)	1.0	1.02			
Width of the Floodprone Area (ft)	64	64			
Entrenchment Ratio	5.77	5.77			

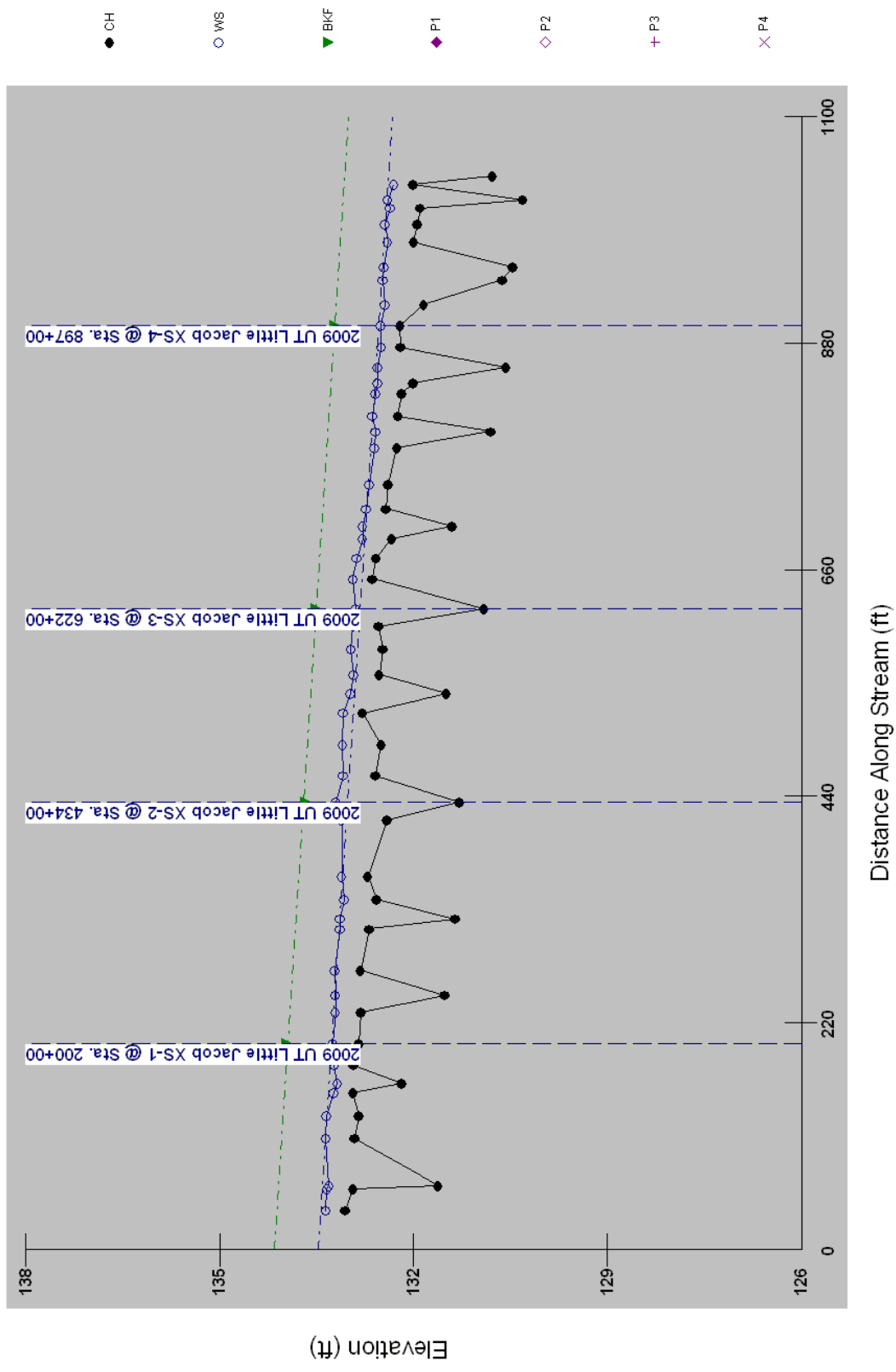
2009 UT Little Jacob XS-11 @ Sta. 2975+00



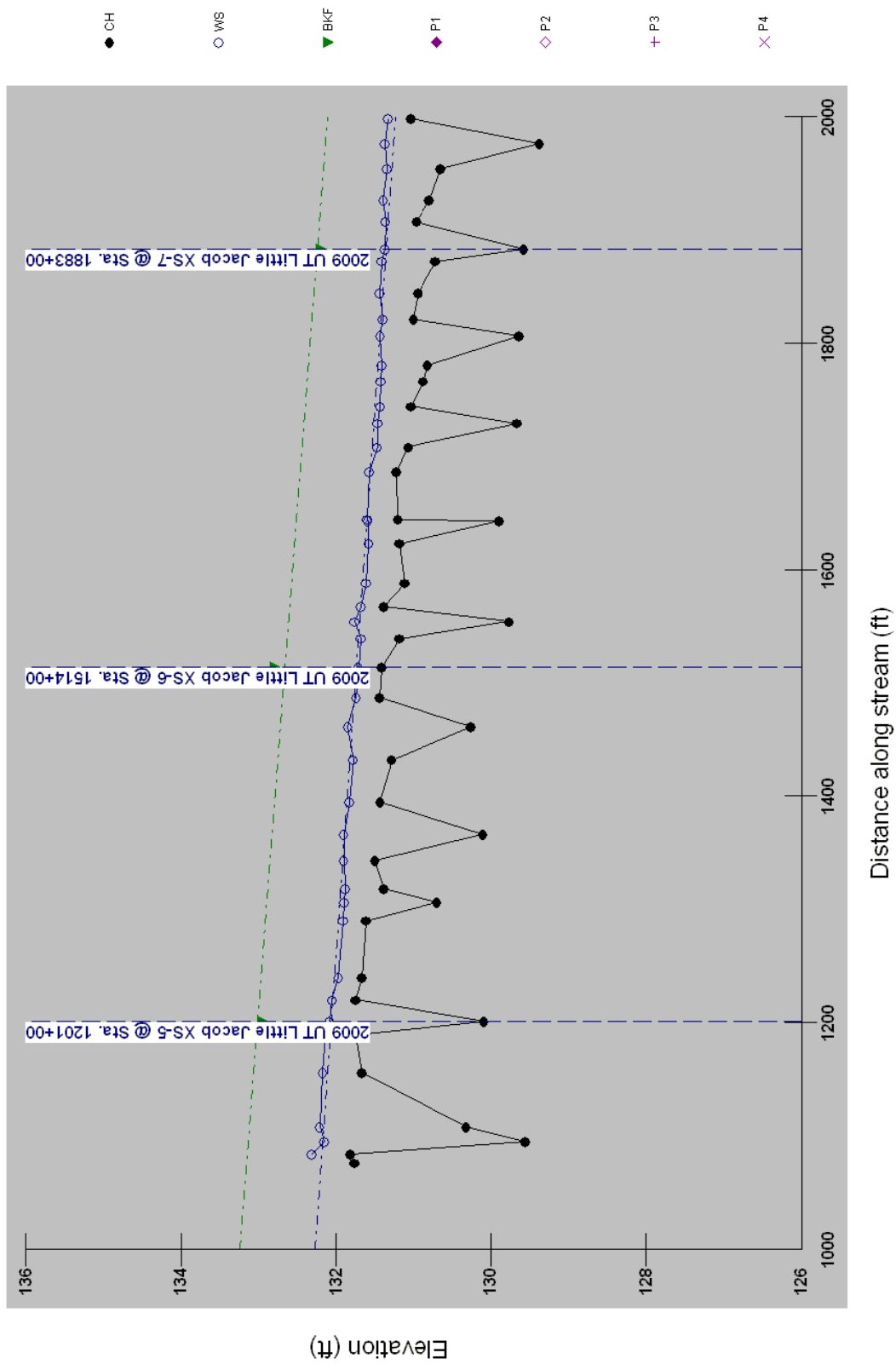
Cross-Section #11 (Riffle) Abbreviated Morphological Summary					
	2008	2009	2010	2011	2012
Bankfull Width (ft)	8.94	9.0			
Bankfull Mean Depth (ft)	0.52	0.42			
Width/Depth Ratio	17.19	21.43			
Bankfull Cross Sectional Area (ft ²)	4.64	3.75			
Maximum Bankfull Depth (ft)	0.74	0.76			
Width of the Floodprone Area (ft)	68	68			
Entrenchment Ratio	7.61	7.56			

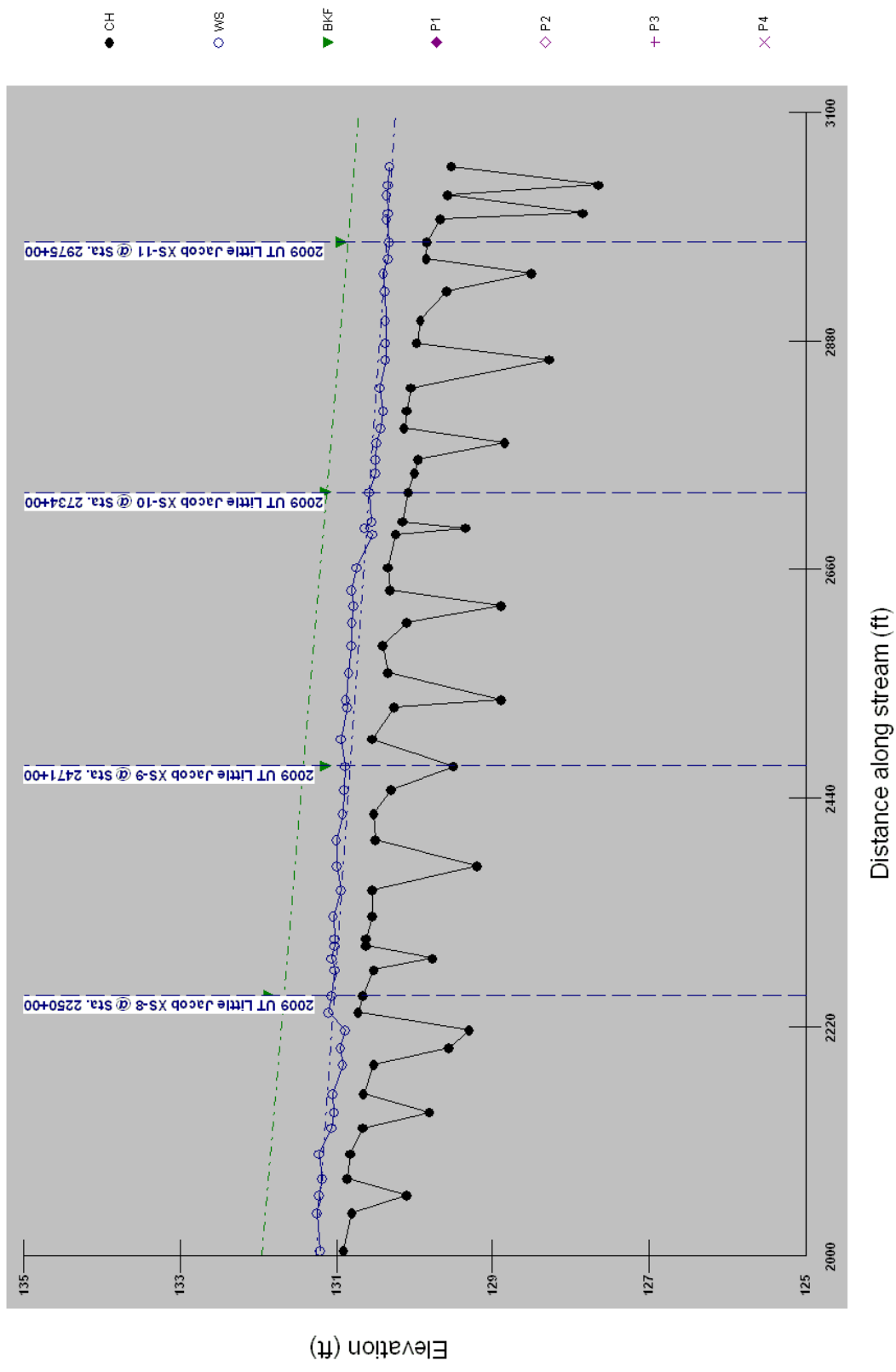
Legend:

- CH: Channel Head (black dot)
- WS: Water Surface (blue circle)
- BKF: Bank Full Flood (green triangle)
- P1: Point 1 (purple diamond)
- P2: Point 2 (purple diamond)
- P3: Point 3 (purple plus)
- P4: Point 4 (purple cross)



2009 UT Little Jacob Longitudinal Profile Sta. 1080+00 to Sta. 2000+00





APPENDIX B

SITE PHOTOGRAPHS, CROSS SECTION, VEGETATION PLOT & PHOTO POINT LOCATIONS

UT to Little Jacob Swamp



Photo Point #1 (Upstream)



Photo Point #1 (Downstream)



Photo Point #2 (Upstream)



Photo Point #2 (Downstream)



Photo Point #3 (Upstream)
November 2009



Photo Point #3 (Downstream)

UT to Little Jacob Swamp



Photo Point #4 (Upstream)



Photo Point #4 (Downstream)



Photo Point #5 (Upstream)



Photo Point #5 (Downstream)



Photo Point #6 (Upstream)
November 2009



Photo Point #6 (Downstream)

UT to Little Jacob Swamp



Photo Point #7 (Upstream)



Photo Point #7 (Downstream)



Photo Point #8 (Upstream)



Photo Point #8 (Downstream)



Photo Point #9 (Upstream)
November 2009



Photo Point #9 (Downstream)

UT to Little Jacob Swamp



Photo Point #10 (Upstream)



Photo Point #10 (Downstream)



Photo Point #11 (Upstream)



Photo Point #11 (Downstream)

